NEXOGENESIS
STREAMLINING WATER RELATED POLICIES

Deliverable 5.3

Implementation report for Lielupe CS

Lead: BEF
Date: February 2025

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003881

Project Deliverable

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Abstract

This Deliverable (D5.3) presents the implementation of the Lielupe Case Study throughout the first 42 months of NEXOGENESIS (September 2021-February 2025). It summarises activities related to the different Work Packages of the project, and outcomes related to: governance assessment, conceptual and system dynamics modelling, and stakeholder engagement. The Deliverable builds on Milestones 15 and 23, synthesizing the case study coordination and execution, and highlighting lessons learned and experiences to date.

Keywords

Lielupe, case study, stakeholder engagement, policies, models, implementation, roadmap, lessons learned, recommendations

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Abbreviations/Acronyms

BEF	*Baltic Environmental Forum, Latvia*
CIR	*Critical Implementation Risk*
CS	*Case study*
D	*Deliverable*
GHG	*Greenhouse gasses*
IHE	*IHE Delft Institute for Water Education*
KPI	*Key Performance Indicator*
LRB	*Lielupe River Basin*
LV	*Latvia*
LT	*Lithuania*
M	*Month*
MCE	*Ministry of Climate and Energy*
MEPRD	*Ministry of Environmental Protection and Regional Development*
MS	*Milestone*
NEPAT	*NEXOGENESIS policy assessment tool*
NGO	*Nongovernmental organisation*
NXG	*NEXOGENESIS project*
PMT	*Project Management Team*
SH	*Stakeholder*
SLNAE	*Self-Learning Nexus Assessment Engine*
STC	*Scientific and Technical Committee*
WEFE	*Water, energy, food, and ecosystems*
WP	*Work package*
WS	*Workshop*

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1. Introduction

1.1. Project Summary

Water, energy, food, and ecosystems (WEFE) are interconnected and comprise a coherent system (nexus), which is characterized by complexity and modulated by climatic and socio-economic drivers. In the nexus, economic development (including optimal trade, market, and policy solutions) is hampered by resource constraints and their interconnectedness. In addition, the adoption of a sectoral approach in developing and implementing policies may affect nexus characteristics, which in turn can affect decision-making and policy formulation/implementation.

NEXOGENESIS (NXG) develops and validates:

a) a coherent cross-sectoral policy-making framework at different scales addressing climate and socio-economic change, as well as stakeholder behaviour and transboundary (diplomacy) issues, developed for and validated by stakeholders, policymakers, and academics;
b) a Self-Learning Nexus Assessment Engine (SLNAE) exploiting reinforcement learning, and supporting streamlining water-related policies into the WEFE nexus;
c) a WEFE Nexus Footprint, accompanying the SLNAE.

Please note that the Self-Learning Nexus Assessment Engine (SLNAE) is hereafter referred to as the nexus/NEXOGENESIS policy assessment tool (NEPAT). This is because this new term is more intuitive for non-project/non-expert readers.

NXG applies its approach to ***five case studies (CS): four European and one in Southern Africa*** (Figure 1). Through these CSs, strong stakeholder engagement and validation of output, the project will improve policies and policy-making processes to enhance cooperation and help the EU achieve targets related to the Water Framework Directive, the greener CAP, Green Deal ambitions, as well as ambitions on water diplomacy.

The five CSs cover diverse spatial, social, cultural characteristics and have a history of development challenges. They also feature strong WEFE nexus relations, with the potential for disruption from policy implementation, and allow for an assessment of how water-related policy can be streamlined into the nexus. They allow for out-scaling to broader regions and, due to the diversity of cases, and the coherent framework, wider-scale out-scaling to other regions globally will be possible. Dedicated CS partners offer access to stakeholder consultation at different tiers, ensuring maximum engagement and project impact.

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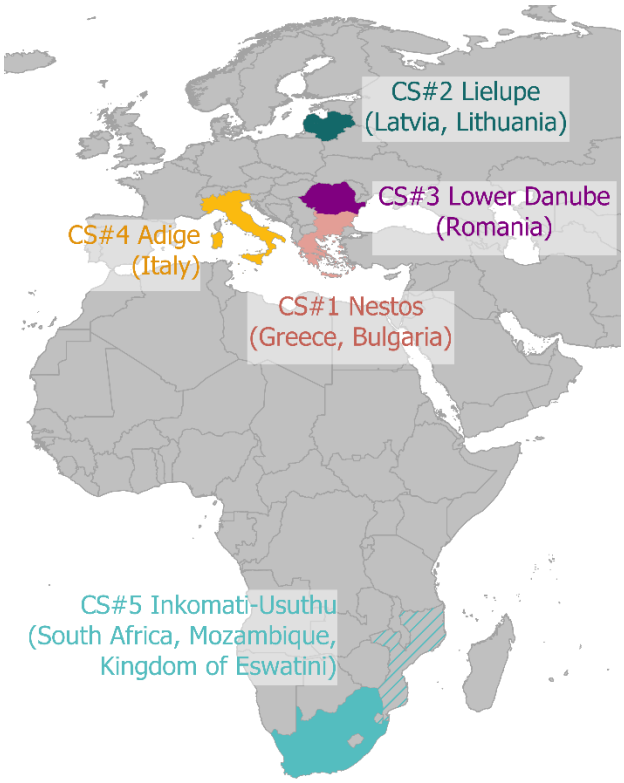
Figure 1: Map of the case studies



Two of the CS, Nestos and Lielupe, are “frontrunner” CSs (see Table 1), which means that they conduct CS activities slightly earlier (ca. 2 months) than others (so called “followers”) to identify potential problems, redundancy or shortcuts in the applied methodology.

Table 1: Overview of the five case studies

Case Study Name	Countries	Project Category
Nestos/Mesta	Greece (GR) Bulgaria (BG)	frontrunner
Lielupe	Lithuania (LT) Latvia (LV)	frontrunner
Jiu, Lower Danube	Romania (RO)	follower
Adige	Italy (IT)	follower
Inkomati-Usuthu	South Africa (RSA)	follower

A detailed description of each CS including a list of main nexus challenges is provided in milestone (MS) 2: *Roadmap for Case Study Work/Activities in NEXOGENESIS*, which also presents deadlines/timings of different activities for the CS, i.e., deadlines when all CSs should have completed the activities to ensure a timely progress of the project.

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1.2. Goals of the report

This second intermediate report builds on MS15 by summarizing the CS implementation and stakeholder co-creation activities during the first 36 months of the project (September 2021-August 2024). It further synthesizes the CS coordination and execution led by WP5, and concludes with emerging CS-specific lessons learned and experiences. The Milestone specifically summarises: CS activities outlined in the NXG Roadmap (MS2), the communication activities relevant for CSs presented in the NXG Internal Communication Plan (MS5), the SH identification process to generate the stakeholder register for each CS described in the NXG Stakeholder Register (MS6), and the monitoring activities outlined in the NXG monitoring plan (MS8). Note that KPIs and risks are being reported by the co-ordinator of NXG (WP7). A full description of the case study co-ordination process in WP5 is provided in Annex 1.

1.3. Methodology to build the report

A transdisciplinary co-creation approach has been incorporated to integrate knowledge and experiences at different levels within the project by applying an iterative process for building, refining, and improving this second intermediate report. The document has been developed during months 30-36 of the project to summarize the CS implementation and stakeholder co-creation activities. The initial outline for this milestone was developed internally and discussed within WP5. After initial elaboration of the document, the draft of the report was sent to leads of all CSs for their inputs and suggestions.

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2. Description of the case study

2.1. Basic characteristics

The Lielupe CS is in the lowland part of north-eastern Europe and covers the territory of the transboundary Lielupe river basin - ca. 17,788 km^2 shared almost equally between Latvia and Lithuania (Figure 2). Around 12% of the Latvian population and around 11% of the Lithuanian population live in this territory. The land area of the basin is predominantly used for agriculture but also includes large areas of forests and urban areas, as well as wetlands and floodplain meadows with protected areas and nature parks. The relief, climate and high soil fertility make suitable conditions for agricultural activities significantly contributing to the economy of the region. Other economic activities in Lielupe CS relate to trade and transport services, as well as the processing industry and public services.

Figure 2: Overview of the Lielupe river basin

In Latvia, the third Lielupe River Basin Management Plan and Flood Risk Management Plan 2022 – 2027[1] has been elaborated by the Latvian Environment, Geology and Meteorology Centre, under supervision of the Ministry of Climate and Energy (MCE) since 1 July 2024 (previously under the supervision of the Ministry of Environmental Protection and Regional Development, MEPRD). Involvement of the main SHs, for example municipalities (local governments) and non-governmental organisations, in the planning process is achieved by means of River Basin District Consultative Boards that are coordinated by MCE.

After completion of the administrative territorial reform in 2021, the Lielupe river basin comprises 12 municipalities in the Latvian territory: Tukums, Saldus, Dobele, Jelgava, Bauska, Mārupe, Ogre, Aizkraukle, Jēkabpils, Augšdaugava, Ķekava, Olaine, and two state cities: Jelgava, Jūrmala.

In Lithuania, the third Lielupe River Basin Management Plan 2022-2027[2] is being developed by the Lithuanian Environmental Agency. The Lielupe river basin includes 11 district municipalities in Lithuania: Biržai, Joniškis, Pasvalys, Akmenė, Pakruojis, Šiauliai, Rokiškis, Kupiškis, Panevėžys, Radviliškis, Anykščiai and two city municipalities: Panevėžys and Šiauliai.

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2.2. Description of the nexus components

2.2.1. Water Sector

The Lielupe river rises at the confluence of the Mēmele (Nemunėlis) and Mūsa (Mūša) rivers near Bauska town in Latvia.

- **Characteristics**: The Lielupe River, with a dense network of slow-flowing rivers, shallow lakes, and ponds, is heavily modified by human activities like river straightening, dams and other obstacles.
- **Hydrology**: Influenced by seasonal floods (spring, summer, autumn) and shallow water periods in summer and winter.
- **Water Quality Issues**: The water quality in water bodies is influenced by pollution loads from point or diffuse sources of agricultural origin, hydro-morphological changes in water bodies due to the straightening of riverbeds in agricultural and forestry lands, and the impact of hydro power plants (HPP). Water quality is generally low, with high nitrogen and phosphorus saturation due to agricultural pollution [3].

  Transboundary pollution from Lithuania worsens water quality in Latvia and the Baltic Sea. Significant amounts of pollution from Lithuania are transported across the border to Latvia and combine with Latvian pollution, which leads to deteriorating river water quality and excessive pollution loads into the Baltic Sea.

  Throughout the Case study implementation, the nature-based solutions are considered to reduce pollution with nutrients along with transboundary contribution aspects

2.2.2. Energy Sector

Energy production from renewable energy sources and fossil fuels plays an important role in the energy balance of the basin.

- **Energy Mix**: Combines renewable sources (wood biofuel, small-scale HPPs) and mainly imported natural gas.

Wood fuel is the most widely used biofuel in the region, for production of heat or in combined heat and power plants. Energy is generated in several small-scale HPPs that affect ecological river flows and fish migration. In recent years, more attention is being paid to increasing the utilisation of wind and solar energy.

- **Renewable Potential**: Underutilized biomass from agriculture, forestry, and food industries. Increasing focus on wind and solar energy.

  Throughout the Case study implementation, implications from expanding wind and solar energy production on land use are considered.

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2.2.3. Food Sector

Agriculture is well-developed in the region.

- **Agricultural Dominance**: 62% of the land is agricultural, producing cereals, potatoes, fodder crops, and supporting dairy farming.

In the food sector, food, and beverage production play an important role in the economy of the region.

- **Food Industry**: Significant economic contributor, producing dairy products, canned fish, grains, meat, confectionery, and beverages.

Throughout the Case study implementation, land use e.g., arable land vs meadows and land use practices affecting all WEFE sectors is considered.

2.2.4. Ecosystems

In the Lielupe CS, aquatic and terrestrial ecosystems are considered in relation to ecosystem services.

- **Diverse Landscapes**: Includes agricultural, agro-forested, forest, wetland, and urbanized landscapes.

During the last decade the area of cropland has increased at the cost of natural grassland habitats – the area of meadows and pastures has reduced.

- **Habitat Loss**: Conversion of natural grasslands into cropland has reduced meadows and pastures.
- **Protected Areas**: Home to national parks and nature reserves, highlighting the region's ecological importance.

Throughout the Case study implementation, aspects to increase bird biodiversity are considered.

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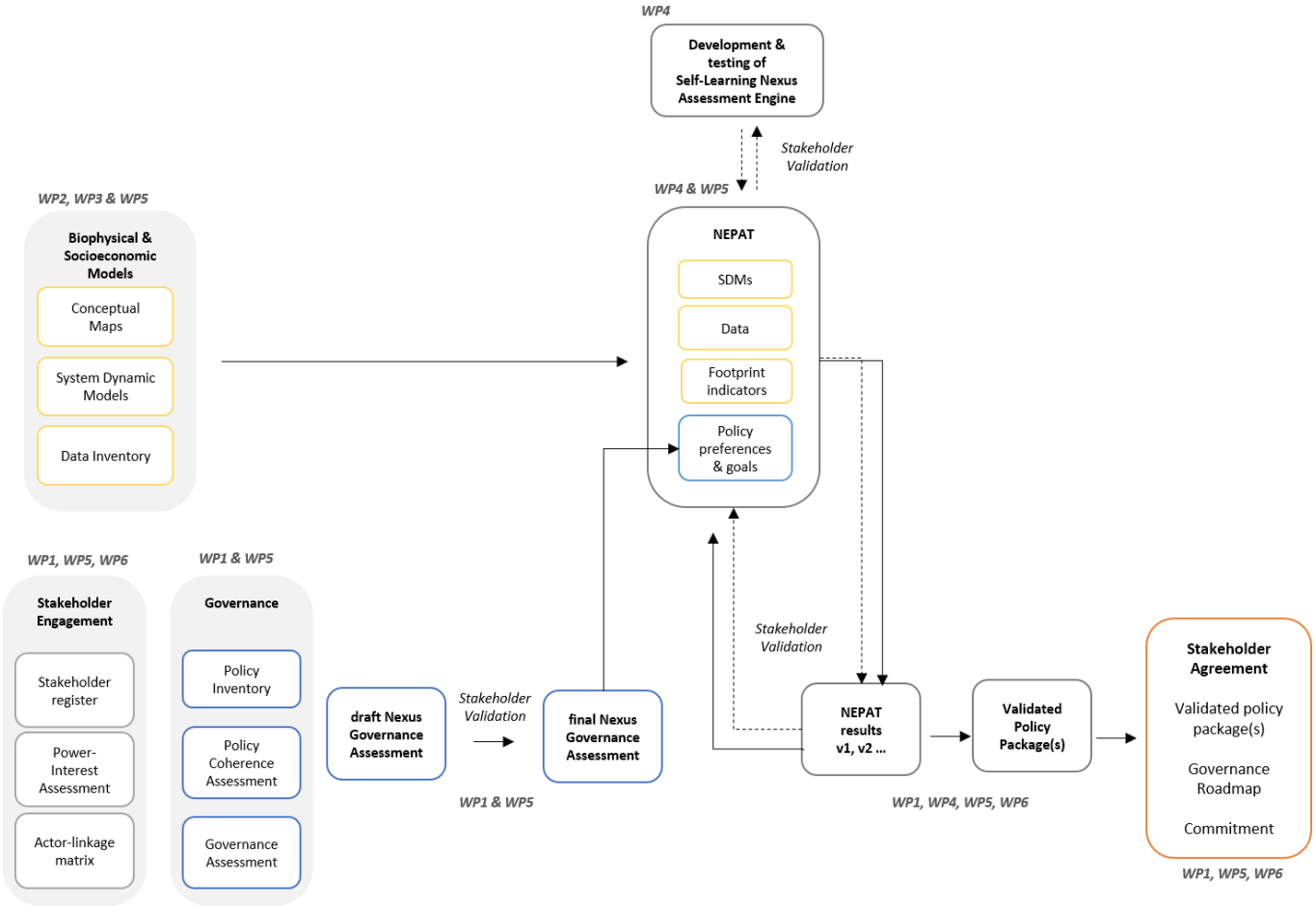
3. Implementation of the case study work in WPs 1-6

This section describes the activities conducted in the Lielupe CS within each WP of NEXOGENESIS. Figure 3 provides an overview of the NXG approach, showing the outputs from each WP and how the WPs are connected. A full list of all individual activities performed during the project can be found in Annex 2.

Figure 3: Overview of the NXG approach, showing the main activities in WP1-6 and the connections between WPs (figure produced by Sabina Khan, UFZ)



3.1. From stakeholder perception to nexus governance assessment (WP1)

The NXG project builds on a coherent cross-sectoral policy-making framework at different scales addressing climate and socio-economic change, as well as stakeholder behaviour and

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transboundary (diplomacy) issues. WP1 specifically focuses on the co-creation of WEFE nexus governance and water policy streamlining. Thus, WP1 creates a water-energy-food-ecosystems (WEFE) nexus governance assessment tool (NXGAT), which is used during the project to measure the quality of existing and potentially future WEFE nexus governance regimes.

3.1.1. Governance assessment in the CS

For the WEFE Nexus governance assessment in the Lielupe river basin, two rounds of case study interviews were carried out in visits to the area between June and September 2022. Interviews were conducted in close cooperation with the WP1 Team (University of Tours, KWR Water) and the Lielupe CS Leads (BEF). The first interview round with SHs in Latvia and Lithuania took place between 6-10 June 2022. To gather additional SH perspectives from Lithuania, the second interview round took place between 15-16 September 2022.

Selection of SHs for interviews was based on data collected in the Stakeholder Register (MS6). Prior to the interviews, invitations were sent to stakeholders representing various institutions and sectors. In addition, the purpose and the logistics of interviews were communicated with each SH directly and individually. A detailed time schedule (program) was elaborated and considered the availability of stakeholders. Interviews were organised at the most convenient time and location, and carried out either face-to-face, remotely or in a hybrid setting. The SHs who agreed to participate in the interviews signed consent forms. Interviews were led by the WP1 team and conducted mostly in English, although in some cases translation to national language was facilitated by CS Leads. In total, 37 stakeholders representing national and regional authorities, scientific institutions, municipalities, business sector, NGOs in Latvia and Lithuania were interviewed. Stakeholders were open, active and willing to share information and their experiences related to nexus governance, main successes and challenges.

Eutrophication of the water bodies in the Lielupe river basin and a lack of environmental and energy expertise at various levels/institutions were raised as the key issues. The initial interview results were presented by the WP1 Team and discussed during the local/regional stakeholder workshop on 29 September 2022 in Bauska, Latvia.

There has been ongoing close collaboration with WP1 on governance assessment for the Lielupe CS. Two focus groups discussions on policy coherence analyses were held online with local and regional stakeholders in Latvia on 9 March 2023 and Lithuania on 31 March 2023. During these events the NEXUS policy integration in the respective country was presented, practical implementation of policy instruments at regional and local level was discussed.

The results from the governance assessment study have been summarized in a report (fact sheet) prepared by WP1. BEF experts have translated the report in Latvian and Lithuanian and have distributed it to the stakeholders prior to the third SH workshop. The results have been presented by WP1 team and discussed at the third SH workshop.

The results of the governance assessment have been further elaborated by WP1 and a deeper insight into the level of integration and existing policy gaps can be found in D1.2 *Governance and Policy Assessment in the Case Studies.* The results of the governance assessment found that the current governance regime in Latvia is ‘restrictive’ towards WEFE nexus governance

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due to top-down decision-making, a lack of environmental expertise at national and local levels, and sectoral perceptions of problems. However, there is an advisory council (inter-ministerial coalition) where representatives of the various ministries are involved in resource management. The situation is similar in Lithuania, where the governance regime is also 'restrictive' because of a lack of involvement of local actors in the development of the RMBPs, a lack of mandate at the local (municipal) scale and no existing regional scale, and a lack of expertise and human resources at all levels. However, Green Deal initiatives at the national level are supporting the cross-sectoral context, and the development of renewable energies and some other specific initiatives are encouraging more cross-sectoral working.

3.1.2. Integrating nexus governance and policy knowledge into modelling and the NEPAT

Policy inventory and coherence assessment

Policy knowledge was obtained in a step-wise approach (as described in *Deliverable 1.1: Stakeholders' co-creation approach for WEFE nexus governance*), beginning with the identification of relevant policies, a performance analysis of the policies and construction the policy inventory, followed by an analysis of policy coherence. Desk research was carried out by the Lielupe CS Lead. This involved screening the policy documents (strategies, plans, guidelines) and legislation (national laws, regulations) in WEFE sectors and River Basin Management Plans: 18 documents from Latvia and 16 documents from Lithuania were reviewed. Analysis of the policy documents was compiled in a template (Excel sheet) elaborated by the WP1 team.

The level of policy coherence was determined by indicating cross-sectoral integration within the policy documents as 'weak', 'strong', 'no integration' and 'not applicable' (with a colour code illustration of results, presented at the NEXOGENESIS PM#1, 28 September 2022, Riga, Latvia). The results from the coherence analyses in Latvia and Lithuania were discussed with the WP1 team and adjusted according to their feedback. Outcomes from the policy inventory and coherence analysis related to WEFE policy goals in Latvia and Lithuania and their cross-sectoral integration were presented to stakeholders at the second SH workshops on 2 November 2022.

Key findings:

- Policy documents are prepared for a defined time-frame and new versions are prepared on a regular basis.
- Sectoral laws adopted 15-25 years ago are frequently amended, e.g. Water management law 2020.
- Documents rather reflect 'yesterday's reality'.
- Comprehensive coherence of Nexus sectors is found in recently developed framework policy documents targeting multiple sectors.

Integration into modelling and NEPAT

Integration of nexus governance and policy knowledge into the modelling and NEPAT for Lielupe CS is done using a step-by-step approach (as described in *Deliverable 1.1*). Results from the policy inventory in Latvia and Lithuania in relation to the Lielupe CS have provided an

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indication of potential impacts on one or multiple WEFE sectors by assessing the degree of integration of these nexus sectors within the respective policy document. The conceptual model of nexus interlinkages (developed in WP3) serves as a helpful aide for assessment and visualization of the points of entry of such policy packages.

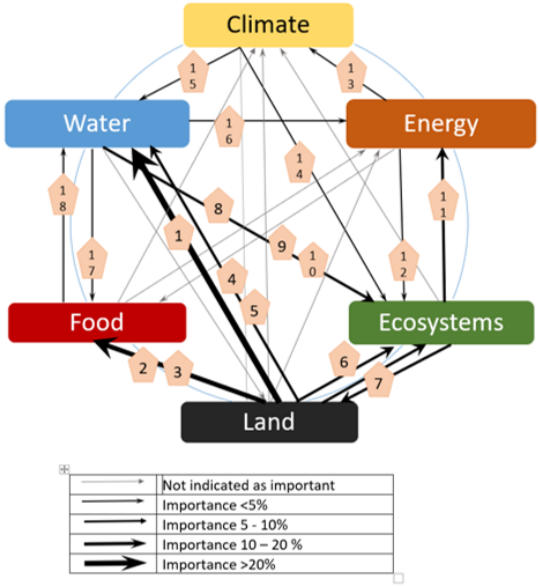
Identification of critical cross-sectoral interactions / issues

An approach to identifying critical cross-sectoral interaction and issues was based on several discussions with SHs:

- Discussion with SHs in Latvia (27 January 2022) on socio-economic development from the municipality perspective; mind-mapping to collect ideas.
- International stakeholder workshop (10 February 2022) to initiate discussion on critical Nexus interlinkages.
- NXG session with LV and LT SHs (27 May 2022) to present the conceptual model and point to the most crucial interlinkages.

The Lielupe CS Lead combined and assessed outcomes from these discussions to develop an initial indication of important interlinkages and the direction of activities within the Lielupe CS (Figure 4). Land-use related interlinkages have been given highest importance by stakeholders.

Figure 4: Important interlinkages of WEFE sectors and potential directions of activities (own compilation)



Nr	Interlinkage	Activity
1	Nutrient leakage, erosion	Creation of environmentally friendly melioration systems
2	Production	Increasing bio-farming
3		Use high-added value crops
4	Drainage	Flood risk management
5		Rainwater management in urban areas
6	Land-use	Minimizing agricultural activities nearby riverbanks
7	Nutrients, yield	Planting high-added value crops; Minimize impacts of agriculture (pesticides) on biological diversity (bees)
8	Ecological flow	Management of fish resources, reduction of dams, barriers
9		Maintenance if biotopes, constructed wetlands, minimization of costal erosion, cleaning of water beds, moving of reeds
10		Nature tourism development
11	Energy production	
12	Energy use	
13	GHG emissions	Use RES, reduce energy consumption
14	Temperature	
15	Precipitation	
16	Energy production	Reduce negative effects of HPPs
17	Water use	
18	Food production wastewater	Modernization of waste-water treatment

The main assessment of critical cross-sectoral interlinkages was linked to the mature development stage of the conceptual model (in WP3) to reflect the full set of interdependencies. Stakeholders in the Lielupe CS were invited to express their opinions on relative importance of Nexus interlinkages (important, moderate, low) by filling the on-line Google form. Timings were adjusted in the second SH workshop to incorporate this task - for Latvia sub-basin (Mid-October to mid-November 2022) and for Lithuania sub-basin (January – February 2023).

An attempt was made to use the Analytical Hierarchy Process (AHP) methodology[4, 5] to evaluate interlinkages and apply the pair-wise comparison. A set of single cross-sectoral

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interlinkages was grouped according to impacts on supply (augmenting) resources, use aspects in a nexus sector, and pressure (pollution) on the nexus sector by other nexus sector activities (Table 2).

Table 2: Grouping of cross-sectoral interlinkages

Nexus sector	Supply	Use	Pressure
Water	Precipitation Temperature	Water use	From point sources From diffuse sources
Energy	Production	Use	GHG
Food	Production	*Not covered*	GHG
Ecosystems	Fertilization Ecological flow	Yield	
Land-use	*Not covered*	Land-cover	

The most critical cross-sectoral interlinkages identified are the effects of precipitation, food production and ecological flow, water use and land cover, as well as water pollution from point- and diffuse sources and GHG from energy sector. The Lielupe CS Lead worked in close co-operation with the IHE project team to uptake these results into the modelling and NEPAT.

During the third SH workshop, the draft set of policy packages (instruments) prepared by BEF team was discussed with stakeholders in four working groups (for each WEFE sector) by using the World Café setting. Each working group had a task to:

- Validate the applicability of proposed instruments in the Lielupe River Basin,
- Suggest additional instruments,
- Indicate potential impacts, effects, trade-offs.

After these discussions, the whole list of selected policy instruments was presented at the plenary, and stakeholders were invited to select the priority instruments by voting (with sticky dots) – 5 dots (votes) per person were given to select at least one priority instrument per sector. The selected approach proved to be successful and gave rather straight forward answers to priority instruments. Voting results indicate that in Water and Food/agriculture Nexus participating stakeholders had a common priority instrument, as nature-based solutions, e.g., constructed wetlands (in Water Nexus) and application of fertilizers (in Food/agriculture Nexus). However, in the Energy and Ecosystem Nexus there were noticeable country differences observed in selection of priority instruments. In Latvia, differentiation of energy sources in the energy mix (in Energy Nexus) and ensuring sufficient ecological flow (in Ecosystem Nexus) were selected. In Lithuania, no clear preference was observed for an instrument (in Energy Nexus) and constructed wetlands for increase of land areas in optimal moisture conditions (in Ecosystem Nexus) were selected.

Voting results indicate that in Water and Food/agriculture Nexus participating stakeholders had a common priority instrument, while in the Energy and Ecosystem Nexus there were noticeable country differences observed in selection of priority instruments (see Table 3).

Table 3: Summary of selected priority instruments

Nexus sector	Lithuania	Latvia
Water	Reduce water pollution load from urban areas: **Nature-based solutions,**	

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Nexus sector	Lithuania	Latvia
	e.g., constructed wetlands for smaller agglomerations (vote: 4-LT, 5-LV)	
Energy	Increase differentiation of energy sources in the energy mix, i.e., solar for small-scale application (vote: 1-LT)	Increase **differentiation of energy sources in the energy mix, i.e., solar for small-scale application**, wind for large commercial application, revenue for municipalities, biomethane 2-nd generation (vote: 8 – LV)
	Reduce GHG emissions from (heat) energy consumption, i.e., energy performance of buildings, energy efficient technologies (vote: 2 – LT)	Not applicable
Food/agriculture	Increase biological farming, i.e., **application of fertilizers**, biologically grown products (vote: 5 – LT, 2 – LV)	
	Alternated agricultural practices, e.g., minimal tillage, certification of fields, soil quality protection (vote: 2- LT, 3 – LV)	
Ecosystem	Increase land areas in optimum moisture conditions, i.e., **constructed wetlands** (vote: 5 – LT)	**Ensure sufficient ecological flow**, i.e., removal of obstacles, river restoration (vote: 6-LV)

3.1.3. Co-creation of policy packages

Key policy instruments and their impacts on WEFE Nexus sectors and on Climate and Land-use in the context of Lielupe river basin were presented and discussed at four moderated break-out working groups during the **first SH workshop** on 10 February 2022. Smaller working groups provided an opportunity for each participant to present their reflections on the topic. For each group, there was a preliminary list of policy instruments prepared in advance, and the participants used this material as a basis for additions and comments during the discussion. Outcomes from this discussion were presented at the plenary session.

Stakeholder involvement in the co-creation of policy packages continued during the **second SH workshop** on 2 November 2022. Participants were introduced to the WEFE policy goals in Latvia and Lithuania and their cross-sectoral integration. Stakeholders were invited to identify the most “powerful” policy instruments (tools, methods) to address specific areas, with the aim of improving resource management and reaching policy goals relevant for the Lielupe river basin. Based on these results, the policy packages for further exploration and integration in the nexus policy assessment tool were elaborated.

Stakeholder involvement in discussion of draft set of policy instruments was continued at the **third SH workshop** on 15 June 2023 in Vilnius, Lithuania. Stakeholders validated the selection of policy instruments in all WEFE sectors, made proposals for additional policy instruments and indicated the priority instruments having the largest impact on WEFE sectors in the Lielupe River basin in Latvia and Lithuania that should be included for further analyses of the modelling and NEPAT. The results of the workshop were summarized and assessed, and the set of policy packages was elaborated in June 2023. It can be acknowledged that policies in both countries often rather indicate the direction of further developments instead of setting measurable

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targets, thus making the monitoring of the policy instrument performance can be quite challenging.

The policy packages (goals, targets, etc.) were elaborated further by BEF team in close cooperation with IHE-Team – several online meetings were held. Henry Amorocho Daza (IHE) took part in the **fourth SH workshop** on 6-7 February 2024 in Riga, Latvia where policy interventions were discussed. Henry gave a presentation of the SDM for the Lielupe CS (8 modules and 220 variables). He introduced the submodules on nature-based solutions applied for reduction of nutrients pollution and policies (measures) to be considered, i.e. woodchip bioreactors and constructed wetlands, and the related impacts resulting in reduction of nitrogen leaching rate in water. The second example highlighted the policies for increasing share of renewables, i.e. solar and wind in final energy consumption and the related reduction in GHG emissions. Feedback from participants was given during plenary discussion in order to validate initial values of the various parameters associated with the proposed policies. In addition, participants provided suggestions to consider in SDM calculations, e.g., on allocation of buffer strips and extension of biological farming.

During the **fifth SH workshop** on 2 October 2024 in Riga, Latvia, along with getting acquainted with the possibilities of the NExus Policy Assessment Tool (NEPAT), stakeholders had an opportunity to explore and test the NEPAT in application of policy packages to reach policy goals in Water-Energy-Food-Ecosystem sectors and to identify the 'must have' policies for achieving the policy goals. Participants were divided into four working groups and each working group was complemented by 1-2 experts from project consortium to consult the exploratory process. The provided supplementary material reflected the currently active reference scenario (RCP2.6, SSP2), policy goals and targets included in the NEPAT for the Lielupe River basin, set of policy instruments that can be applied for testing. Policy makers at different levels, representatives from universities, NGOs, agriculture and municipalities, with the support of the platform's developers, explored the tool's capabilities and provided valuable feedback to improve the user experience.

The further co-creation with stakeholders on policy packages is planned during the **focus group meetings** in Latvia and Lithuania to be organised in March-April 2025. User-validated policy packages are planned to be discussed and verified with stakeholders during **the sixth SH workshop** in April 2025.

3.1.4. Governance roadmap

Elaboration of the governance roadmap for the Lielupe CS (in cooperation with WP1: Sabina J. Khan, UFZ) has started with the SH validated selection of policy instruments in all WEFE sectors and continued through NEPAT results to obtain policy advice to achieve WEFE policy goals. Nexus Governance Roadmaps highlight the pathways to implement the chosen combination of policies taking into consideration (i) enabling environment (conditions that support implementation (policy, legal, strategic planning), (ii) institutions & participation (range and roles of political, social and economic stakeholder groups), (iii) financing (funding and budget coordination from various sources).

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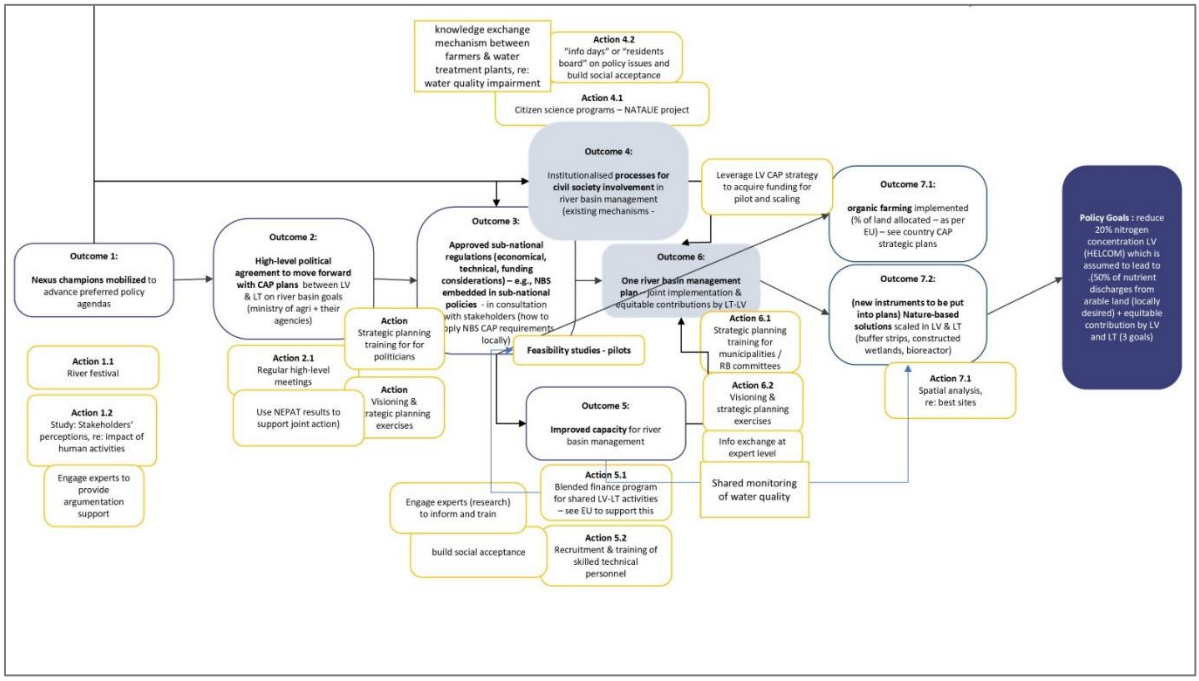
Suggestions from participating SH and NXG project partners (fifth SH workshop, on 2 October 2024 in Riga, Latvia) were obtained for governance related improvements in the Lielupe RBD. Set of individual contributions by participants was collected and further used as a basis for drafting the Roadmap.

Further discussion on developing the governance Roadmap has taken place during the WP1 & WP5 Workshop (on 15-17 January 2025 in Athens, Greece). The draft Roadmap highlights the pathways for achievement of goals for reduced nitrogen concentration in Latvia and Lithuania. Implementation of this Roadmap composes seven intermediate steps (outcomes) to succeed the policy implementation in the Lielupe River Basin. Notably, the transboundary context is accounted as a prerequisite (Figure 5). Development of additional pathways is planned for achieving of goals in energy sector and ecosystems (biodiversity). User validation will take place at the Focus groups (March-April 2025) with finalisation of the Roadmap at the sixth stakeholder workshop (April/May 2025).

Figure 5: Draft Roadmap for achieving the policy goal to reduce nitrogen concentration in the Lielupe RB.



3.1.5. Stakeholder agreements

During the interviews performed in Latvia and Lithuania, stakeholders in both countries expressed a wish for closer cooperation between countries for improved management of the Lielupe river basin. To initiate a discussion about possibilities for cross-border and 'beyond the projects' co-operation between local and regional institutions in the Lielupe river basin in Latvia and Lithuania, a stakeholder workshop was organised on 29 September 2022 in Bauska, Latvia. During this event, stakeholders selected and prioritised possible cross-border cooperation actions that could be implemented to improve stakeholder networking and water resource management in the Lielupe river basin. Coordinated river cleaning activities and a transboundary "Lielupe Festival" to showcase practical results, achievements, and increase visibility of actions stakeholders are proud of were pointed out as most attractive and necessary. This workshop can be regarded as a first step towards facilitating process towards

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the design and adoption of a (transboundary) stakeholder agreement for integrated management of the Lielupe river basin resources (river contracts).

Discussion on facilitation towards stakeholder agreement was continued at the **fourth SH workshop** 6-7 February 2024, in Riga, Latvia. In cooperation with WP1 (Caro Mooren, KWR) there were key elements of a stakeholder agreement, step-by-step process description and the timeline to reach the stakeholder agreements presented. Discussion among participants highlighted the main topic for cross-border cooperation related to water quality issues in the Lielupe RB. The proposed format included working group meetings, local practical actions, involving River Basin Authorities (LV/LT), National, Regional and Local level stakeholders.

Stakeholders appreciated the proposal of the Baltic Environmental Forum taking a role of a focal point of maintaining the cross-border cooperation of stakeholders in the Lielupe River basin. Study visits and experience exchange were identified as the most wanted form of cooperation. By the year 2028, in the frame of Horizon project NATALIE, the Baltic Environmental Forum can act as a focal point for the actions – initiating, leading, and facilitating the cooperation process e.g., organizing joint events. The NXG project is aiming to develop a Governance roadmap for the implementation of the SH agreement action plan. Validation of the roadmap and the stakeholder agreement is envisaged to take place during the **sixth SH workshop**.

3.2. From biophysical and socio-economic data to incorporating baseline scenarios in the System Dynamics model (WP2)

WP2 focuses on identifying and bringing together relevant nexus data, creating a coherent scientific portfolio of data across case studies to characterize physical, environmental and socio-economic components under current and future climate change conditions through the coming century. The portfolio is developed in line with a set of selected IPCC scenarios, as a combination of shared socioeconomic pathway (SSP) and representative concentration pathway (RCP) scenarios. The goal is to provide data support for each case study (WP5) concerning appropriate nexus data combinations and modelling design for WP3 and WP4 and under SH acceptance and co-development in WP1 and WP5, to characterize relevant case-specific biophysical-human interactions between nexus components.

3.2.1. Biophysical variables

Biophysical variables from WP2 were used as parameters of the System Dynamics model (SDM) of the Lielupe River Basin. A detailed account of the variables considered in the SDM can be found in the Deliverable 3.6 of NEXOGENESIS. This report explains the input data of

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the case study and the strategy taken to account for uncertainty and sensitivity in the modelling process. In short, the features of the biophysical data provided by WP2 offered the possibility to account for two types of uncertainty in the SDM: scenario and parametrical uncertainty. Four RCP-SSP combinations were considered (RCP 2.6 and 8.5; SSP2 and 4). Additionally, each scenario combination offered a wide range of parametrical uncertainty for several parameters of interest across the LRB WEFE system. These features also facilitated the estimations of having ranges, instead of deterministic values, for the output variables in the SDM across the four scenarios of interest. Such capabilities facilitated having a robust approach for evaluating the expected impact of Nexus policies in a simulation environment, first in the form of the SDM and, later, via the NEPAT tool implementation.

3.2.2. Co-creation of technical and transdisciplinary knowledge

To define policy interventions to reach the policy objectives and policy goals, the key interlinkages between respective nexus sectors (as “provider” and a “recipient”) were identified during the Lielupe CS conceptual model development (in WP3). Quantitative description of these interlinkages is essential for modelling and WEFE Nexus footprint estimations in relation to the achievement of policy objectives.

The CS Leads have a close cooperation with WP2 (CMCC and CAF teams) and WP3 (IHE team) for translating the interlinkages into units reflecting physical and socio-economic development terms. The CS Leads have prepared the initial overview describing the interlinkages and attributing them to respective units in climate, water, food, energy, ecosystems, and land-use sectors. Meetings have been arranged to discuss the interaction with modelling outputs from WP2 and to indicate needs for inputs and particular data for modelling part in WP3. The co-creation work was directed to Lielupe CS technical and transdisciplinary knowledge.

Initial screening of data availability vs data needs for SDM for the Lielupe CS has been carried out. More recently, the interaction with WP2 has been mostly indirect for the Lielupe CS, mostly through the IHE team elaborating SDM. BEF team has been all the time included in the communication/discussion loop. BEF provided data to SDM modelling team (IHE) and not directly to WP2 team that mainly got any data for various sources.

3.3. From conceptual model to complexity science modelling and WEFE nexus footprint (WP3)

WP3 forms the link between the biophysical modelling (WP2) and stakeholder input (WP1) and integrates the outcomes of these WPs through novel complexity science approaches. These approaches assess the impacts of water-related policies in a nexus context in the CS under

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different scenarios, according to the requests of WP5 and the stakeholder input and recommendations from WP1.

3.3.1. Overview of interrelationships among WEFE Nexus components

The conceptual model of the Lielupe CS (Figure 6) shows the interrelations between WEFE Nexus components and considers the interrelations between land-use and climate. The **water** nexus component focuses both on water availability and water quality. Availability of water is considered for application in energy production by hydropower plants where potential effects from precipitation and water level fluctuations can have an effect, as well as water use in food production and ensuring of sufficient ecological flows for ecosystems. Water quality, however, is affected by nutrient load and erosion from land-use activities, and discharge of (treated) wastewater from urban settlements and production units.

Energy consumption and production from various renewable and fossil sources play an important role in the energy balance of the country and have an impact on climate via GHG emissions. The energy production by-product – digestate when applied on land as organic fertilizer - has an impact on the nutrient balance in agriculture and forest areas.

The **food** sector comprises both rainfed and irrigated (mainly in greenhouse) crop and vegetable production patterns. Another activity - livestock production - is considered with a particular focus on potential nutrient supply by organic fertilizers (manure) in land-use applications subsequently influencing ecosystems. Food processing is included to reflect the food industry and it considers related effects on the water and energy nexus.

The conceptual model distinguishes aquatic and terrestrial **ecosystems.** Ecosystems provide biomass for energy production, serve as resource for food production, and play a role in the GHG balance, thus having an impact on climate change.

3.3.2. Main WEFE Nexus challenges

The main challenges of WEFE Nexus in the Lielupe CS have been identified at the initial stages of NEXOGENSIS project in cooperation with the WP5 Lead [6]:

Expansion of arable lands on expanses of grasslands is putting pressure on grassland habitats, e.g., loss of semi-natural meadows that ultimately leads to decline in biodiversity and the related ecosystem services in the basin.

Homogenisation of land due to vast areas of continuous arable land fields diminishes the quality of landscape and the stability of ecosystems.

Heavy fertilization to increase the crop yield leads to increased nutrient leakage in water courses, thus posing a risk of deteriorating water quality and water ecosystem services.

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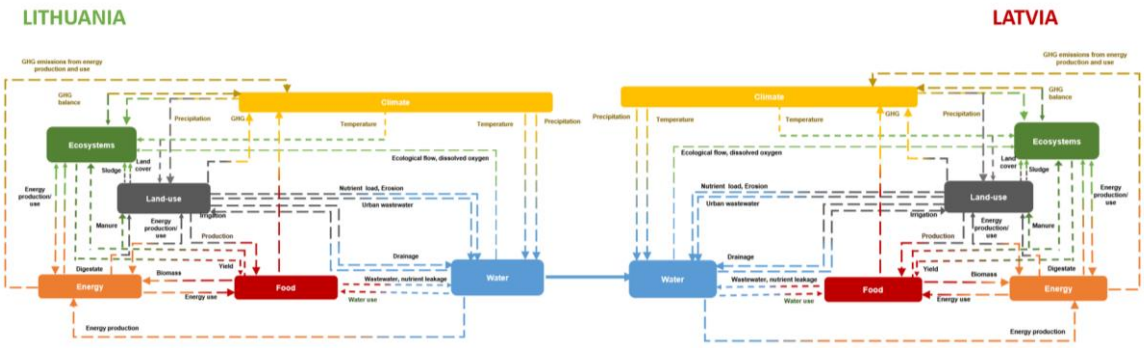
Alternative income sources such as tourism or recreational activities put additional pressure on the ecosystem. Small hydropower plants also negatively affect fish migration and the river's ecological flow.

Water diplomacy issues (i.e. transnational aspects) also play a role because significant amounts of pollution from Lithuania are transported across the border to Latvia. Local pollution in Latvia is also added, leading to deteriorating water quality and excessive loads of pollution in the Baltic Sea.

3.3.3. Conceptual Model

The conceptual model for the Lielupe CS (Figure 6) was developed by the CS Lead, utilising knowledge about the main nexus interlinkages in the Latvia CS implemented in the SIM4NEXUS project. However, for applicability in the NXG project, several modifications were necessary to cover water, energy, food and ecosystem sectors, and consider interlinkages within the land-use and climate nexus components. In-house expertise, literature research, internal discussions and consultations with various experts were utilised. During the development process, the CS Lead experts cooperated closely with the IHE team to justify the relevance of the interlinkages. The Lielupe CS conceptual model has been presented and discussed with stakeholders at various stages of its development at several events (10 February 2022; 27 May 2022; 02 November 2022).

Figure 6: High-level conceptual model of the Lielupe CS



The conceptual model of the Lielupe CS focuses on the Lielupe river basin divided in two sub-systems, one for Lithuania and another one for Latvia, where the connection is ensured by the water nexus component. Detailed sectoral models are provided in the NXG *Deliverable 3.1: Conceptual models completed for all the case studies*, December 2022 (pp. 23-32).

3.3.4. System Dynamic Modelling approach

The first preliminary version of the Lielupe SDM is available in Deliverable 3.4: *Complexity science models implemented for all the Case Studies: Prototypes and explanatory report/manual for each CS methodology*. The SDM for the Lielupe CS was completed by the IHE team in February 2024 and further revised in October 2024. Its successful completion was facilitated by frequent communication and consultations on updates and information/data

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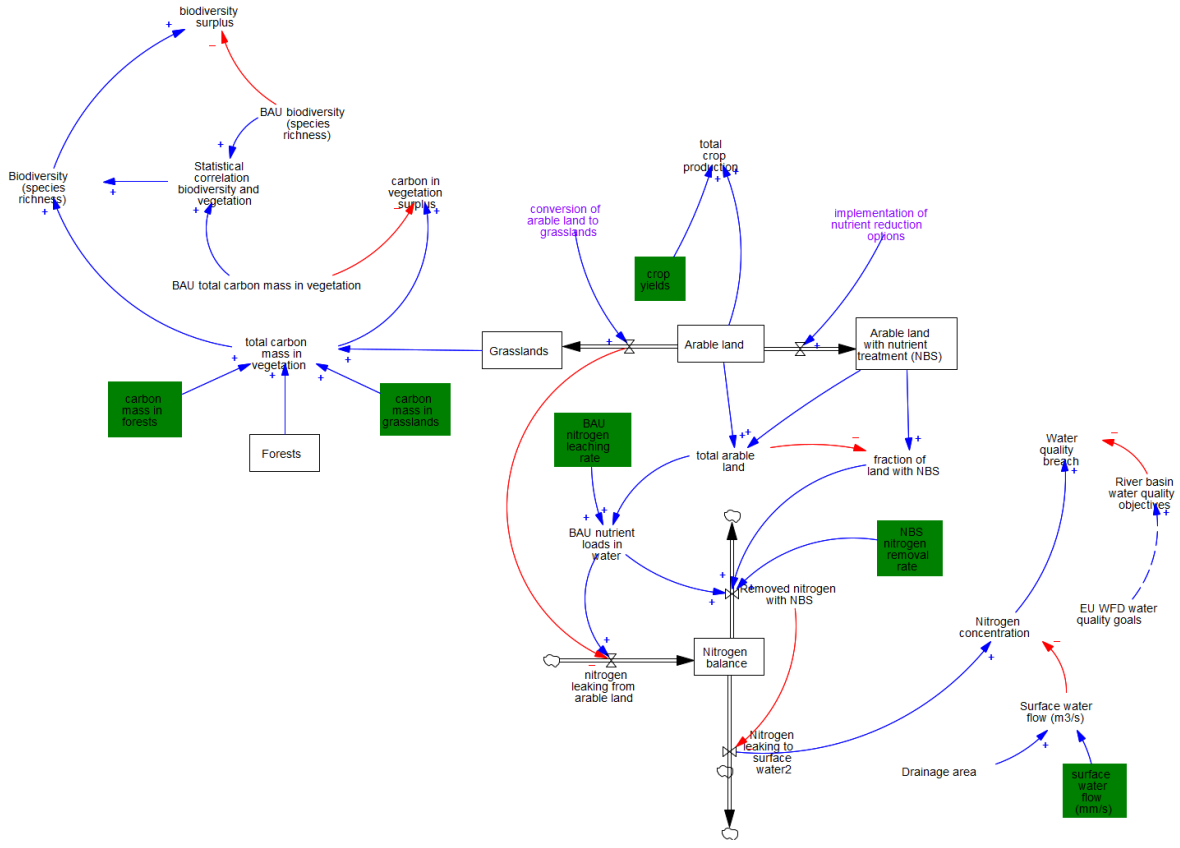
exchange between IHE and BEF. The BEF team has taken part in regular WP3 working group meetings reflecting the most recent developments in the case study.

The System Dynamic Modelling (SDM) approach of the Lielupe CS was developed by the IHE team in cooperation with the CS Lead. The SDM of the Lielupe CS consists of subsystems representing the nexus sectors and relevant socio-economic development trends. The development process started with rounds of discussions related to important nexus interlinkages and data requirements for populating of the SDM. Representative data sets for the Lielupe river basin nexus sectors were of pivotal importance for developing the SDM and are described in detail in the NEXOGENESIS' Deliverable 3.4.

The LRB SDM was developed following a participatory approach as described in Amorocho-Daza et al (2025)[7]. An overview of the model is presented in Figure 7 in the form of a Stock and Flow Diagram. Building on the conceptual model and policy priorities extensively discussed in the first three stakeholder workshops in the river basin, the simulation model was crafted to test the impact of nexus policies in various sectors, such as *water*, *food*, and *ecosystems*. The model focuses on simulating the effects of long-term land-use change across multiple nexus sectors. Policies such as the implementation of nature-based solutions (NBS) to control arable land nutrient pollution and the extension of grasslands are of particular interest.

Figure 7: Overview of the Stocks and Flow Diagram for the Lielupe River Basin.



By considering the transboundary nature of the river basin, the model explicitly incorporates the upstream-downstream effect of such policies. For instance, Figure 8 shows the long-term effect of taking unilateral versus bilateral cooperation to improve water quality in the LRB until

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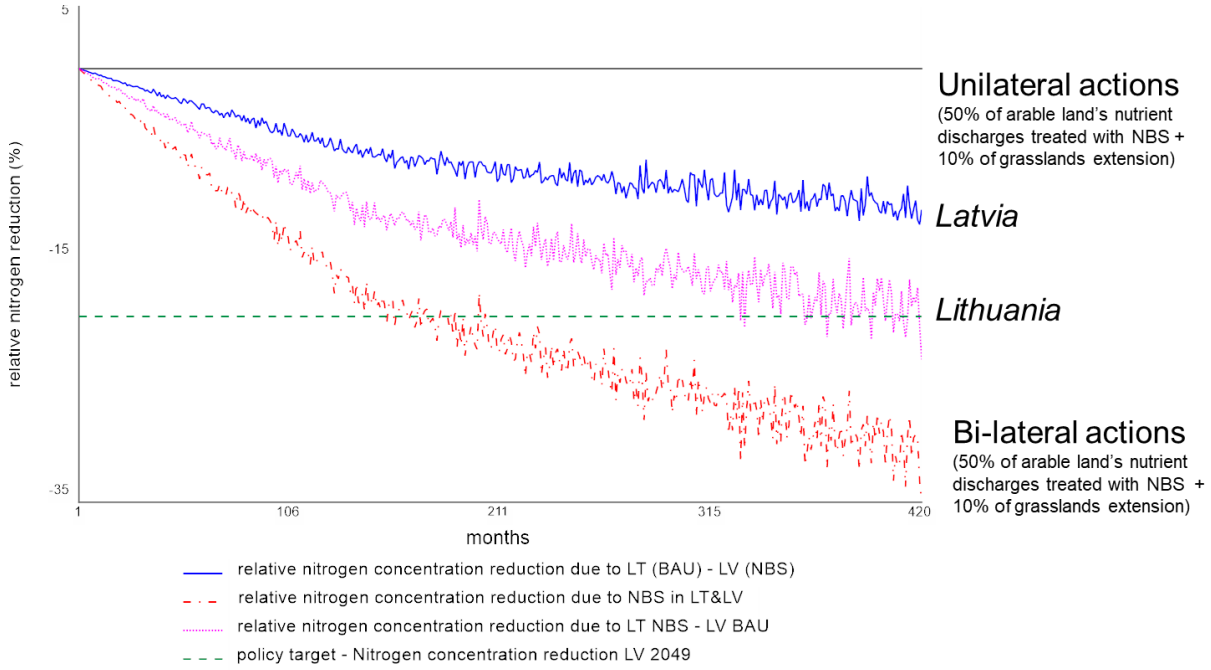
2050. Finally, it is worth mentioning that the modelling capabilities of the SDM are further exploited in the NEPAT tool; a user-friendly decision support tool that can be used by the stakeholders of the LRB.

Figure 8: Modelling water quality improvement comparing unilateral action vs. bi-lateral cooperation in the LRB



3.4. From nexus governance and complexity science modelling to nexus / NEXOGENESIS policy assessment tool NEPAT (WP4)

The objective of WP4 is to develop the nexus policy assessment tool (NEPAT) to distil integrative policies that maximize the overall nexus benefits while dealing with conflicting nexus decisions and objectives.

3.4.1. Identification of relevant policy packages which sustain initial development of NEPAT

The work of co-creating relevant policy packages for the Lielupe CS is being performed through interaction between the CS Lead and WP1, WP3 and WP4 Teams. The development of the NEPAT has been based on the outcomes from the policy inventory and selection of policy instruments. In total **eleven policy goals** have been selected for the Lielupe River Basin:

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- Goal 1: Reduce the nitrogen concentration in Lithuania by 8% in 2027 (intermediate goal)
- Goal 2: Reduce the nitrogen concentration in Lithuania by 15% in 2050
- Goal 3: Reduce the nitrogen concentration in Latvia by 10% in 2027 (intermediate goal)
- Goal 4: Reduce the nitrogen concentration in Latvia by 20% in 2050
- Goal 5: Equitable contribution from Lithuania to control transboundary nutrient pollution
- Goal 6: Equitable contribution from Latvia to control transboundary nutrient pollution
- Goal 7: Increase the renewable energy generation (Wind and Solar) in the Lielupe River Basin to reach a potential of 700 GW/h by 2050
- Goal 8: Compensation of arable land GHG emissions by installing renewable energies
- Goal 9: Increase bird biodiversity by 20% in 2027
- Goal 10: Promote organic farming in Lithuania
- Goal 11: Promote organic farming in Latvia

For reaching the above-mentioned policy goals, the following policy instruments (P1-P11) on the national (Latvia, Lithuania) scale or an the Lielupe River Basin scale have been discussed and agreed with stakeholders to be included in the NAPAT:

- P1 - Riparian Buffers LV (implementing Riparian Buffers in Latvia as an alternative to control diffuse nutrient pollution)
- P2 - Riparian buffers LT (implementing Riparian Buffers in Lithuania as an alternative to control diffuse nutrient pollution)
- P3 - Bioreactor and constructed wetlands LV (implementing Bioreactors and Constructed Wetlands in Latvia as an alternative to control diffuse nutrient pollution)
- P4 - Bioreactor and constructed wetlands LT (implementing Bioreactors and Constructed Wetlands in Lithuania as an alternative to control diffuse nutrient pollution)
- P5 - Biological farming LV (implementing Biological Farming in Latvia to control diffuse nutrient pollution)
- P6 - Biological farming LT (implementing Biological Farming in Lithuania to control diffuse nutrient pollution)
- P7 - Land with nutrient reduction in LV (fraction of land for implementation of nutrient reduction options in LV. Options include riparian buffers, bioreactors and constructed wetlands, and biological farming)
- P8 - Land with nutrient reduction in LT (fraction of land for implementation of nutrient reduction options in LT. Options include riparian buffers, bioreactors and constructed wetlands, and biological farming:
- P9 - Land for renewable energy (fraction of grasslands use to install renewable energy (solar PV and wind) at the Lielupe river basin scale)
- P10 - Increase grasslands LV (allow conversion of 10% arable land to grasslands LV)
- P11 - Increase grasslands LT (allow conversion of 10% arable land to grasslands LT)

These policy goals, along with supporting policy instruments have been translated into parameters and functions for the NEPAT in further project implementation activities. The CS Lead has been regularly participating in WP4 co-creation discussions to design the tool for the benefit of Lielupe CS stakeholders.

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During preparation for the **fourth SH workshop**, the CS Lead - BEF team was in communication about the NEPAT development with the WP4 team (Eurecat). Nuria Nievas and Chaymaa Dkouk El Ferroun participated at the workshop and introduced the functionalities of the NEPAT to the workshop participants. The presentation was followed by interactive discussion on NEPAT functionalities. Participants were invited to provide feedback on the NEPAT functionalities, navigation possibilities etc. by using MentiMeter tool, participants were asked to give feedback on several discussion questions. Participants noted that having a User Guide for the NEPAT is essential. Additional explanatory material with respect to climate scenarios and pathways, modelling approaches and data sources in clear and simple language is needed and will be helpful for SHs to build the necessary background to provide fruitful feedback. This information has been traced within the NEPAT tool and the IHE-team has translated the policy packages into parameters for the NEPAT. Participants expressed their interested to see the results of the NEPAT trial for Lielupe CS.

The **fifth SH workshop** served for demonstration of possibilities of NEPAT and for giving an opportunity for the stakeholders to explore the tool in operation to identify the 'must have' policies for achieving the policy goals. After a guided tour to NEPAT provided by L. Echeverria Rovira, (Eurecat), participants in smaller groups were Exploring and testing possibilities of the NEPAT in application of policy packages to reach policy goals in Water-Energy-Food-Ecosystem sectors. A supplementary material for testing of the NEPAT was provided to stakeholders. The material reflected the Currently active reference scenario (RCP2.6, SSP2), policy goals and targets included in the NEPAT for the Lielupe River basin, set of policy instruments that can be applied for testing.

The NEPAT tool incorporates a set of policies co-identified with the stakeholders as useful for improving the WEFE nexus challenges of the LRB. Users can manually select one or multiple policies and test their effect on previously identified goals in the basin. Figure 9 presents the LRB NEPAT tool interface for policy selection, and Figure 10 shows the goals summary of implementing a selected policy package. In addition to the manual exploration of policies, the NEPAT tool offers advanced capabilities – a machine learning-powered decision-support system (DSS) – to identify well-performing policy packages that allow the fulfilment of one or multiple goals according to stakeholder priorities. Figure 11 shows the interface of the DSS.

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Figure 9: LRB NEPAT tool - policy selection interface

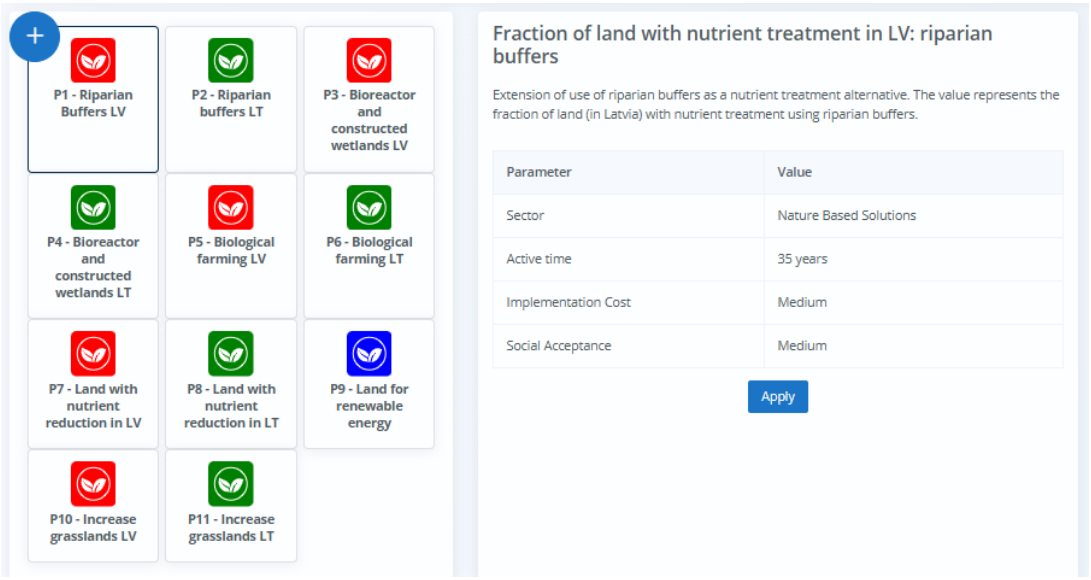

Figure 10: LRB NEPAT tool - goals view interface

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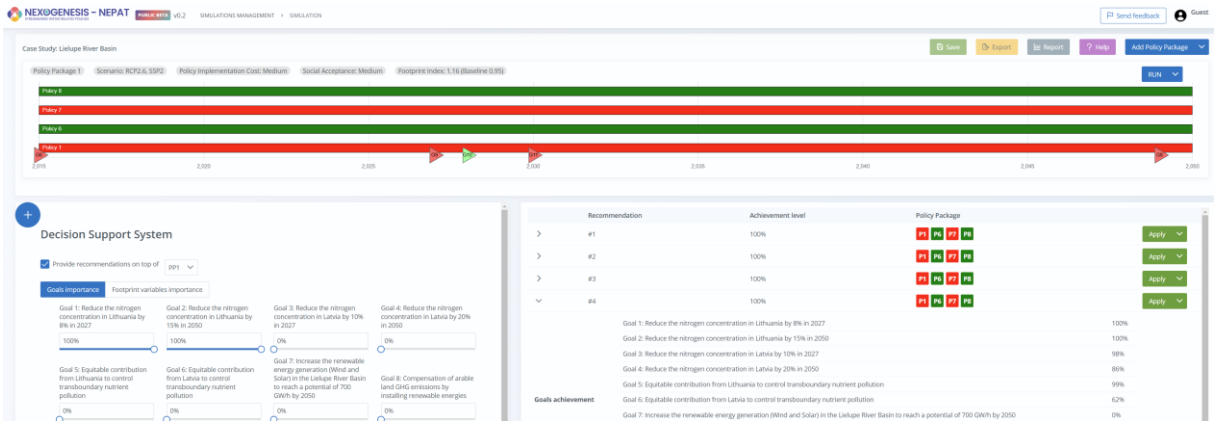
Figure 11: LRB NEPAT tool - Decision Support System interface



A final iteration of improvement of the NEPAT tool is currently under development, after receiving stakeholder feedback in the 5th SH workshop (on 2 October 2024 in Riga, Latvia). Finalised NEPAT will be introduced during the Focus groups and presented in the 6th SH workshop at Lielupe River Basin.

3.5. Stakeholder engagement and stakeholder workshops (WP5)

The stakeholder engagement plan is based on the data, information and perceptions provided and analysed by the CS Leads, the CS stakeholders and the AVA- and UU-team (Deliverable 5.1).

NEXOGENESIS follows a 5-step stakeholder engagement process:

- **Step 1** is the definition of the SH engagement aim to ensure a clear process and allow defining expectations and communicating to the SHs their role in the co-creation process.
- **Step 2**, stakeholder analysis, starts with the identification of who should be involved where and how (e.g., SH 1 should be informed, whereas there should be close collaboration to empower SH 2) by classifying stakeholders and analysing their relationship to the project, as well as to each other.
- **Step 3**, stakeholder engagement plan, assesses the SH's interest to identify incentives and benefits that can drive their engagement in the project.
- **Step 4**, stakeholder management and sustainment, determines how to maintain this interest and engagement of the SH throughout the duration of the project and how to sustain the SH's engagement beyond the lifetime of the project.
- **Step 5** aims at evaluating the participatory process and its effects on the project, as well as on the CS's objectives. MS6 describes methods for Steps 1 and 2, whereas D5.1 will describe the methods for all remaining steps.

The Lielupe CS implementation team sees involvement of SHs in the case work activities as of pivotal importance. The aim of involving a wide range of people as defined in the Stakeholder Engagement (SHE) Plan[8] is twofold, as it provides the ground for SHs to express their views

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and perceptions about the overall development of the Lielupe river basin, and to obtain different types of knowledge to be accounted for in nexus assessment work.

SHs from Latvia and Lithuania have a potential interest in the development of the Lielupe river basin. Engagement of SHs in the Lielupe CS complies with the NXG stakeholder engagement process. Stakeholder groups (at national, regional, and local level) that have direct or indirect impacts in the region have been considered.

Step 1: Definition of the SHE aim

This step was initiated early in the implementation of the project to ensure a clear process of mapping and approaching SHs, along with defining expectations and communicating the role of SHs in the co-creation process. The CS Lead worked in close cooperation with the AVA team in completing this step. It is the aim to generate the following types of knowledge (Table 4).

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Table 4: SHE aims at Lielupe CS

Early engagement (12 month)	Mid-project engagement (24 month)	Late project engagement (36 month)
System knowledge		
Characterize social, economic, ecological, and institutional contexts associated with regional development planning.	Characterize social, economic, ecological, and institutional contexts associated with regional development planning.	Characterize social, economic, ecological, and institutional contexts associated with regional development planning.
Improve understanding of the water quality issues (the status quo and targets)	Improve understanding of the water quality issues (the status quo and targets)	Improve understanding of the water quality issues (the status quo and targets)
Gain understanding of the River Basin Management Plans between both countries	Gain understanding of the River Basin Management Plans between both countries	Gain understanding of the River Basin Management Plans between both countries
Target knowledge		
Determine what set of solutions that balances different sectors by their design and scale of applicability	Determine what set of solutions that balances different sectors by their design and scale of applicability	Determine what set of solutions that balances different sectors by their design and scale of applicability
Knowledge of potential conflicts between the agricultural and ecological sectors	Knowledge of potential conflicts between the agricultural and ecological sectors	Knowledge of potential conflicts between the agricultural and ecological sectors
Determine innovative systems for sustainable production	Determine innovative systems for sustainable production	
Transformation knowledge		
Gain understanding of how to improve communication between stakeholders, as well as the requirements of an appropriate platform to do so	Gain understanding of how to improve communication between stakeholders, as well as the requirements of an appropriate platform to do so	Design communication pathways between various level stakeholders to ensure practical involvement and cooperation
Determine suitable pathways to design and implement formal agreements for the case of a transboundary river basin	Determine suitable pathways to design and implement formal agreements for the case of a transboundary river basin	Determine suitable pathways to design and implement formal agreements for the case of a transboundary river basin
Design and implement suitable ways for coordinated management between the countries	Design and implement suitable ways for coordinated management between the countries	Design and implement suitable ways for coordinated management between the countries

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In general, SHE aims largely remained throughout the project implementation particularly with respect to the system knowledge and target knowledge. With more mature project implementation the transformation knowledge has been focused on pathways for practical involvement and cooperation in a transboundary river basin.

Step 2: Mapping of stakeholders in the preliminary stakeholder register

This step was aimed to identify SHs who potentially could be engaged in the Lielupe CS implementation activities (i.e., information, consultation, involvement, collaboration, empowerment). The CS Lead began by collecting, listing and storing basic information about individuals, entities or organizations in Latvia and Lithuania (according to the "stakeholder register" template provided). Contacts and knowledge of potential SHs from previous relevant projects were an asset. Publicly available contact information on respective webpages was used to extend the coverage of SH groups, e.g., local authorities, local and regional enterprises, and businesses. The stakeholder register (an Excel document) is maintained as a living document and updated periodically with new entries of identified stakeholders added during the course of project activities (e.g., workshops, interviews, expert groups).

Obtaining consent from SH to take part in the Lielupe CS

This step focusses on obtaining consent from individual SHs for participation in the CS and inclusion in the stakeholder register. SHs were asked to complete a consent form designed for this purpose. As a preparatory step, the consent form was prepared and adjusted in Latvian and Lithuanian languages for the convenience of local SHs. The CS Lead is applying various strategies to recruit potential stakeholders. These include:

- A project e-mail to a group of people after the project event with forwarded presentation slides, materials, and invitation to sign the consent form. However, a low response rate to the consent form was observed.
- An individual e-mail to a person after the project event with thanks and forwarded presentation slides, materials, and an invitation to sign the consent form (if not already completed). A significant increased response rate to the consent was observed.

Contacting stakeholders, e.g., listed people in the preliminary stakeholder register is implemented on a continuous basis.

3.5.1. Overview of current stakeholder landscape

Identification of SHs and obtaining consent for their participation in the Lielupe CS are continuous processes and the SH landscape evolves over time (Table 5).

Table 5: Overview of identified SHs in the Lielupe CS

	Preliminary	Without consent	With consent (PPCF)
No. of total identified SHs			
as of September 2022 [9]	75	52	23 (30.7%)
as of December 2022	82	52	30 (36.6%)
as of December 2023	96	66	30 (31.3%)
as of December 2024	118	88	30 (25.4%)

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3.5.2. Summary of engagement approach

In the development of the SHE Plan by WP5 as guidance for organizing SHE and achieving the SHE aims, the CS Leads were involved in scoring the different co-creation approaches for the themes of purpose. The most suitable mode for co-creation in the Lielupe CS was identified as “Navigating difference” (with an added consideration of producing knowledge). The plan across all phases of SHE for the Lielupe CS was also elaborated (a short overview of engagement activities is presented in Table 6).

Table 6: Overview of engagement activities in Lielupe CS

	Co-exploration	Co-design		Co-development	
	Information	**Consultation**	**Involvement**	**Collaboration**	**Empowerment**
SH category (expected - given NXG aim)	All categories	All categories, care taken to avoid SH fatigue.	All categories from all WEFE sectors, e.g., sectoral authorities and potential users of the NXG tools.	All categories; particular focus on sectoral authorities, local policy makers.	Empower research and academic sector, together with local municipality and policy makers.
Power and Interest (PI)	All being informed, emphasis on low power – high interest category	High power – low interest SH to their interest. Low power – high interest SH to their area of expertise and interest.	High power – high interest SH for the discussion and involvement of high power – low interest SH.	All PI categories.	All PI, keep interest of high-power SH.
CS focus and activity	Inform about events, diversity of SH, agreements, networking, project findings.	Consult about perception of networking, SH interests, roles, potential conflicts, cooperation potential.	Involve in discussions, exchanges, building trust, sectoral interests, the results of consultation activities.	Share knowledge to raise awareness on current issues, interlinkages between sectors.	Ensure space for providing feedback, expose perceptions, discuss conflicts, and power dynamics.

3.5.3. Summary of workshops

WP5 supports the application of the NXG approach in the five case studies. NXG builds on co-creation, both within the consortium and with stakeholders. Thus, CS workshops with stakeholders are an important building block of the SHE strategy. The summary of the **key 5 stakeholder workshops** organised within the frame of the Lielupe CS (first SH workshop on 10 February 2022, online; second SH workshop on 02 November 2022, in Riga, Latvia; third

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SH workshop on 15 June 2023, in Vilnius, Lithuania; fourth SH workshop on 6-7 February 2024, in Riga, Latvia; and the fifth SH workshop on 2 October 2024, in Riga, Latvia) is presented in Table 7. The final sixth SH workshop is planned to be organised in April 2025.

Below the table is a summary of the gender distribution of participants.

Table 7: Summary of workshops, including main goals, structure, outcomes, experiences and lessons learned

Workshop No.	Goals	Structure, activities	Main outcomes	Experiences (positive/ negative aspects of the workshop)	Lessons learned. e.g., which methods/tools were successful/not successful? Suggestions for improvements?
1	To initiate the discussion about the critical WEFE Nexus interlinkages in the Lielupe CS.	Plenary presentations, moderated working group discussions, survey on stakeholder interest, perceptions, contributions, and expectations regarding the NXG project.	SHs became acquainted with NXG project, provided inputs for identification of nexus interlinkages (conceptual model), important policy instruments.	(+) International setting from diverse representation of countries and institutions provided wider perspective in discussions. (+) Contribution from participants on WEFE Nexus interlinkages. (+) Moderation of discussions lead to tangible results and practical suggestions. (-) SHs from the business sectors were underrepresented.	(+) Advanced preparation of background materials (draft conceptual model and list of policy instruments) were successful for providing indicative directions and initiating active discussions at the event. Time should be allocated for introduction of participants.
2	To validate the conceptual model, to discuss cross-sectoral integration of policy goals, to identify the most influential policy instruments.	Plenary presentations, interactive discussions at plenary, individual reflection of SHs on important policy instruments (measures) having impact on nexus interlinkages.	Obtained SH viewpoints on nexus interlinkages, important policy instruments - perspectives of farmers, nature protection, wastewater management experts.	(+) SH represented all WEFE sectors, the discussion provided valuable suggestions for further cooperation and information exchange. (-) Overlap with meetings/workshops organized by other institutions, involving the same SH groups.	Future SH engagement approach could include personal communication e.g., visiting municipalities, other SH highlighting the project in connection with local problems and possible solutions NXG could deliver.

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Workshop No.	Goals	Structure, activities	Main outcomes	Experiences (positive/ negative aspects of the workshop)	Lessons learned. e.g., which methods/tools were successful/not successful? Suggestions for improvements?
3	To introduce findings from the governance assessment in LV& LT, to present and validate policy packages, to discuss stakeholder engagement, to promote networking.	Plenary presentations, working groups, individual contributions for validation & prioritisation of policy instruments.	Validation of WEFE policy instruments, proposals for additional ones, prioritisation of policy instruments.	(+) Application of different modes of interaction with stakeholders (+) Networking session in the workshop (-) Overlap of events causes competition between NEXOGENESIS SH workshops and other international conferences.	SH register needs to be regularly updated with SH actively working in WEFE sectors.
4	To introduce results of SDM, the NEPAT, possibilities for stakeholder agreements.	Plenary discussions, national working groups, feedback on NEPAT by Mentimeter, individual reflection on additional information/ clarification needs.	SH feedback obtained for improvement pf NEPAT, policy instruments in SDM, ideas for sustaining transboundary cooperation.	(+) SH participation from various levels (national, regional, local). (+) Good balance between plenary presentation & interactive working group sessions. (-) Lack of explanatory information provided beforehand to participants on climate scenarios and data for modelling.	Longer time allocation is needed for the networking session. Combining the workshop with a site visit.
5	To demonstrate possibilities of the NEPAT, to give opportunity for the SH to explore it in operation	Plenary presentations, working groups to explore NEPAT, individual contributions on governance issues, pre-workshop	In-depth exploration and testing of the NEPAT by potential users, valuable feedback obtained to improve the user	(+) Presence of NEPAT developers, SDM modellers at the workshop	Providing supplementary materials (e.g. for NEPAT) to participants either prior to the event or during it is important

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Workshop No.	Goals	Structure, activities	Main outcomes	Experiences (positive/ negative aspects of the workshop)	Lessons learned. e.g., which methods/tools were successful/not successful? Suggestions for improvements?
		survey/post workshop debrief, evaluation survey	experience		

Workshop No.	Males*	Females*
Workshop 1	12	21
Workshop 2	5	13
Workshop 3	7	14
Workshop 4	7	20
Workshop 5	7	13

** including consortium partners participating at the events*

3.5.4. Summary of the effects of the engagement activities

SHE activities in the Lielupe CS have comprised five forms of interaction: information, consultation, involvement, co-design and empowerment activities.

Information about the NXG project, its activities and implementation schedule have been communicated to stakeholders since the early stages of the project and during every interaction with stakeholders (workshops, interviews). Background information was provided to give SHs better insight into the project framework.

Consultation with stakeholders was the key activity implemented during the workshops in the Lielupe CS – WP5 SH WS1, SH WS2, SH workshop in LV, working group session, WP1 interviews and local/regional SH workshop (see Annex 3**Fel! Hittar inte referenskälla.**). For maximisation of SH inputs, the CS Lead has applied various tools – mind-mapping, discussions at smaller facilitated working groups, prioritisation of possible joint activities in Lielupe river basin, and prioritisation of nexus interlinkages (online survey). Advanced preparation of background materials (including the draft conceptual model and a list of policy instruments) and providing these materials prior to each event, was successful in providing indicative directions and initiating active discussions. The selected approach to involving stakeholders and providing the opportunity for them to express their individual views was well appreciated by stakeholders. The CS Lead in turn has obtained valuable inputs for the CS implementation.

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Collaboration (design process with inputs) with stakeholders was implemented in SH WS2 by validating the conceptual model of Lielupe CS. During the event, valuable ideas and thoughts from stakeholders were obtained, discussions were active and reflected different views from the perspectives of farmers and nature protection experts, wastewater association representatives, etc. Collaboration was intensified in subsequent project implementation periods.

Co-design (developing solutions) with stakeholders was implemented in SH WS3 and SH WS4 by validating the policy packages for further incorporation in the NEPAT developed to the Lielupe River Basin.

Empowerment (implementing solutions) of stakeholders to implement the steps designed by the Roadmap to achieve policy goals will be in focus at the Focus group discussions and SH WS6. To sustain the established SH cooperation beyond the project duration, the SH agreement will be made operational.

3.6. From policy recommendations to impact maximization (WP6)

In this NXG project reporting period within WP6 the Lielupe CS Lead will strive to achieve the following aims within a Policy Impact Log that will be completed during the project implementation:

> *The initial policy influence objectives for the Lielupe CS focus on improving the governance and management of the WEFE nexus and designing integrated policies governing the WEFE nexus, with the benefit of co-creation with stakeholders. The EU policies on water management, renewable energy, common agriculture, ecosystems and biodiversity, climate change mitigation in Latvia and Lithuania are targeted. Policy makers at local level (municipalities) and national level (ministries), regional administration (planning regions), developers of River Basin Management Plans (centres, agencies), researchers (universities, institutes), professional associations (water management, farmers, energy), environmental NGOs, and businesses (food, etc) are targeted.*

3.6.1. Impact maximisation

In the Lielupe CS various SH groups i.e., municipalities, planning regions, water management entities, farmers, business, are related to the governance and management of the WEFE nexus within the Lielupe River Basin District as a part of fulfilling their daily business and duties. National policy makers and agencies set the legal frame and thus regulate activities at regional and local levels. Environmental NGOs and local initiatives are largely involved in activities within the river basin. Researchers play a role in developing and providing science-based solutions for efficient resource management. The NXG project has been aiming to improve the governance and management of the WEFE nexus in the Lielupe CS by taking into consideration the diverse landscape of involved players who utilise common resources and face similar issues. In the D.6.11. “Policy impact strategy”[10] is outlined the process for

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evaluation of overarching policy impact for the NXG policy impact. Here the key message for impact maximisation at the Lielupe Case study are reflected.

1. **A capacity problem** that is often experienced by all SH groups involved. Municipalities point out that personnel capacity is not sufficient in regions and there is a noticeable uneven distribution of resources between cities and rural municipalities. Insufficient capacity is sometimes noticed e.g., of water resource management operators to understand the treatment requirements, and farmers to understand requirements for environmentally friendly agricultural practices. It is crucial **to develop and use tools for capacity building**.

2. **Cooperation** between various SH groups in the governance and management of resources in Lielupe CS is implemented to a limited extent for targeting specific requirements or problems. Cross-sectoral cooperation could be enhanced by creating awareness of WEFE interlinkages. Trans-boundary cooperation for information and data exchange at the national level is implemented to some extent. Cooperation between Latvian and Lithuanian border municipalities in the Lielupe CS is implemented at project level and thus it is important **to sustain these practices beyond the project's scope**.

3. **Mainstreaming nature-based solutions.** Nature-based solutions have been prioritised by SHs as policy instruments. Lielupe CS Leads would rate it as an achievement if nature-based solutions are mainstreamed in various sectors e.g., agriculture, forestry, urban environment. However, the time frame of the project will be too short to see this. Such initiatives must be continued along with allocation of financial support schemes.

4. **Degree of stakeholder engagement.** At the start of the SH workshops, participants were more likely to obtain new information on approaches and methods to be used in the project, while at the later stages they contributed actively with their knowledge to shape the project outcomes. Stakeholders are showing an increasing trust in project results as they see them being developed based on scientific approaches. Throughout the project activities, stakeholders were consulted and encouraged to provide inputs to the NEXOGENESIS topics in relation to Lielupe CS. Reflection via gradual build-up of project outputs, e.g., conceptual model, SDM, governance assessment, allowed for stakeholder suggestions to be incorporated. Uptake of SH inputs was highlighted during the presentations at the SH workshops. This was strengthened by regular participation of the project partners in charge of project key outputs in Lielupe CS for direct interaction at a professional level.

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4. Lessons learned and experiences

During communication with the CS implementation team, SHs have acknowledged the applicability of the Nexus approach to cross-sectoral and transboundary issues in Lielupe River Basin management. However, at the same time they admit to using the silo approach in conventional implementation practices.

4.1. Implementing the SHE process

Acknowledging the need to widen the range of stakeholders and invite the most relevant specialists from Latvia and Lithuania, the SH register has been updated with new entries (names of SH) representing institutions at national/regional and local – representatives from public and private bodies, research and NGO. In comparison to the initial SH list, SH enlargement activities resulted in several new institutions from Latvia and Lithuania participating that have not been participating at earlier events (see Annex 3). The core SH group in Latvia is formed by representatives from Latvia University of Life Sciences and Technologies, Latvian Environment, Geology and Meteorology Centre and Bauska County municipality. In Lithuania the most active (engaged) SHs are from Center for Environmental Policy (AAPC).

It has been observed that stakeholders are much more eager to sign the consent form once they have participated in a project event (workshop, interview, meeting) where they have learned about the project, its activities, planned results and outcomes. Therefore, right after each event a personalized 'Thank you e-mail' has been sent to a 'new' stakeholder together with an invitation to sign a consent form (online link is provided to fill in the form in the national language).

Before each SH workshop information about the project, its goals and activities have been sent to the stakeholders along with the "save the date" message. Short before events the detailed workshop program and supplementary materials were provided to the workshop participants to be prepared for the discussions e.g., during the working groups.

4.2. Improving the SHE process

Having implemented the 3rd SH workshop, the CS implementation team has realized that the SH register needs to be revised and updated accordingly with those SHs committed to participating in the NXG activities (having signed the consent forms). New SHs needed to be engaged to ensure coverage of SH groups from WEFE sectors.

The CS implementation team has observed that it is advisable to keep the face-to face workshop approach, invite project partners including modelers and tool developers, as they are the ones who could provide scientific support which is of high importance. Sending supplementary background information materials to participants prior to the event is always very much appreciated by stakeholders. Participants were interested to see the results of the NEPAT and willing to participate in joint transboundary activities in the Lielupe River basin.

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The interest of stakeholders and their readiness to be engaged in project activities have remained high. They joined the workshops until the end of each one, showing their high interest.

Obtaining feedback from SHs via evaluation questionnaires, as well as learning from other CS on SHE approaches, successes and challenges is always useful to get inspiration for agenda development and communication tools to be applied during the interaction with SHs at the events. Asking participants for feedback during the event is the most effective way vs. sending the evaluation questionnaire sometime later.

NXG project workshops provided a forum for an exchange of viewpoints of SHs from different levels (national/regional/local) and various sectors. Stakeholders were highly interested to participate in the discussions, learning about the project results and the tools developed.

Timely and regular interaction with SHs by informing, consulting, involving, collaborating and empowering is required throughout the whole project duration. SHs are willing to share their knowledge, allocate time for participation in the project activities if they see that the project outputs would be beneficial for their everyday practices, or lead to improvement of policies, raising of knowledge, etc. Use of local language helped to provide the general overview of the project but for trans-boundary CSs it is important to have a common language approach. The presence of NXG consortium experts was appreciated because they were able to answer technical questions in detail.

4.3. Integrating sectors in the NEPAT

4.3.1. Motivating stakeholders to use the NEPAT

Observations from the workshops indicate that participants were actively asking clarification questions about baseline scenario, modelling uncertainties, verification and matching the real situation in the river basin. Additionally, participants made suggestions for the platform and navigation options of the NEPAT. This might be considered as a prerequisite for intention from stakeholders to use the NEPAT in their daily business.

The possibility to test different policy packages for reaching the policy goals and to seek for suitable combinations relevant for the Lielupe River Basin in Latvia and Lithuania serves as a motivating factor for stakeholders to use the NEPAT in practice. NEPAT clearly indicates the benefits of actions if implemented in both countries, thus giving a scientifically soundproof for importance of transboundary efforts of Latvia and Lithuania to improve the water quality in the river basin.

4.4. The overall NXG co-creation approach

Application of various tools for co-creation has been well appreciated by stakeholders i.e. combination of presentations with interaction during smaller working groups that provided individual contributions. Diversity of communication methods and tools unfolded creativity of stakeholders to support NXG objectives. Cocreation approach was used to prioritize WEFE

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nexus critical interlinkages for the Lielupe RB and make the policy instrument selection to be incorporated in the NEPAT.

4.5. Transboundary dimension

The transboundary context within Lielupe CS was addressed throughout the NXG implementation activities. The conceptual map for Latvia and Lithuania was connected through the Water nexus. SDM results have shown better achievement of nutrient pollution reduction goals when implementation of measures is taken in both countries. Transboundary dimension is reflected in NEPAT by set of policy goals and instruments. The (draft) Roadmap comprises set of activities (steps) to be implemented in a transboundary setting.

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5. Conclusions

This section comprises some thoughts and experiences from implementation of the Lielupe CS at the current stage of the project (February 2025):

- High work intensity in the NXG project has occurred for tackling WEFE issues comprehensively and addressing governance, policy, nexus interlinkages and SH involvement simultaneously. This approach required careful planning of resource allocation towards WPs and task implementation.

- The main nexus challenges for the Lielupe CS are related to: (i) water quality impacted by nutrient load from diffuse and point sources, (ii) energy production from renewable energy sources creating additional pressure on other nexus sectors e.g. water, land use, ecosystems (iii) intensive agriculture that applies fertilisers, (iv) pressure on terrestrial ecosystems due to homogenisation of land, growing monocultures, and on aquatic ecosystems due to fluctuations in hydrological regime, (v) exploitation of natural resources creating pressure on ecosystems (e.g., loss of habitats and biodiversity). These challenges are reflected in the conceptual model and SDM of the Lielupe CS. Initial results from exploring the NEPAT and Decision support system highlight advances of joint activities in Latvia and Lithuania for achieving the policy goals.

- Involvement of SHs from WEFE sectors at various levels (national, regional, local) is of crucial importance for the implementation of the Lielupe CS. To date, the SHE activities have related to providing information and to consultation. Collaboration and empowerment of SHs in CS implementation will be activated.

- The CS Lead acknowledges that closer cooperation (at national and transboundary levels) between SHs should be established during elaboration and implementation of River Basin Management Plans. Bringing up the issue on cooperation beyond the implementation of the NXG project at local, regional and national levels will help to facilitate a process that aims to design and adopt (transboundary) SH agreements for integrated management of the Lielupe river basin's resources.

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Annex 1: WP5 – Description of Case Study Coordination

WP5 supports the implementation of the NXG approach in the five CSs through:

a) the development of a roadmap that guides the work of CSs in NXG;

b) the management of internal communication between CSs and WPs;

c) the development and implementation of a stakeholder engagement strategy;

d) the continuous coordination and monitoring of all CSs activities.

Special emphasis is placed on the provision of guidelines and training supporting stakeholder engagement processes in the five CSs, as stakeholders provide valuable inputs to the WPs (WP1-4). The WP5 guidance leads to better integration of the project results coming from the different WPs. This work helps to maximize the impact of the project (WP6).

The work of WP5 is complementary to Task 1.3 in WP1. Task 1.3 ensures the coordination of WPs1, 2, 3, 4 and in particular the timely and effective flow of information between the technical WPs (2, 3, 4) and the policy and governance work package (WP1) based on the input received from stakeholders from CSs. As such, WP5 work connects all the other WPs in the project. An overview of the links between WP5 and other WPs is presented in Figures 7 and 8 in MS2 - *Roadmap for Case Study Work/Activities in NEXOGENESIS*.

Throughout WP5 (months 1-48), five (5) tasks, seven (7) deliverables and six (6) related milestones are set with specific dates and timelines. A timeline of these WP5 activities can be found in MS2 - *Roadmap for Case Study Work/Activities in NEXOGENESIS*, Figure 9. They all require close collaboration of the WP5 team with each CS lead and coordination with other WPs. CS leaders play a critical role in co-developing the guiding documents (e.g., the CS roadmap) by expressing their needs, their preferred mode of communication, their ability to contribute with local knowledge, and by validating the developed guidelines, documents, and roadmap.

The first milestone of WP5 (MS2 – *Roadmap for Case Study Work/Activities in NEXOGENESIS*) concerns the development of a roadmap for CS work with the aim of guiding CSs in NXG and more particularly their contribution to each WP. It constitutes a timeline for all relevant activities described in relation to the work and needs of all relevant WPs (WP1-4).

The second milestone of WP5 (MS5 – *Internal Communication Strategy*) is a practical resource that fosters the communication between CS leaders and WP leaders, but also supports the exchange of relevant information/experience among the leaders of different CSs as further explained below.

The third milestone of WP5 (MS6 – *Stakeholder Register*) presents the stakeholder (SH) identification process to generate the SH register for each CS. This document reports on the steps and considerations given to CS leaders for the identification of the respective relevant SHs. It also provides preliminary results for each CS including the categorization of different SH groups according to their engagement interest and function.

The fourth milestone (MS8 – *CS Monitoring Plan*) includes activities to enable WP5 to monitor the CSs work and potential amendment actions (if needed, in the case of delayed work). Its

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aim is to facilitate the progress of the CS activities, thereby ensuring a successful implementation of the project work in each CS.

The fifth milestone (MS15 – *Intermediate report on case study implementation and co-creation activities*) provides detailed internal monitoring of case study implementation activities during months 1-18 of project (September 2021-December 2022).

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Annex 2: Schedule of all activities performed

The table below includes a list of the key activities conducted/planned within the Lielupe CS involving stakeholders (SH) throughout the NXG project between September 2021 and February 2025.

Date	Type of Activity	Purpose	Participants
Oct 2021 - ongoing	**SH mapping and SH register**	To identify the stakeholders playing a role in the Lielupe river basin in Latvia and Lithuania for further SH engagement in NXG activities (WP5).	CS Lead, WP5 Team.
Jan – Nov 2022	**Development of conceptual model**	To identify and select water-energy-food-ecosystems (WEFE) nexus interlinkages, key nexus challenges (WP3).	CS Lead, WP3 Team, Lielupe CS Stakeholders.
27 Jan 2022 online event	**SH workshop (LV)** *"Interlinkages between water-energy-food-ecosystems within the Lielupe river basin considering development of the region and municipalities"*	To start the stakeholder engagement process and discuss potential activities in the Lielupe river basin. Focus on interlinkages between WEFE and the effects of climate change and the socio-economic development from (local/regional) municipality perspective in order to obtain inputs (via mind-mapping) for development of the conceptual model for the Lielupe CS (WP3).	LV policy makers at national and local level, regional authorities, scientific institutions (universities), public initiatives, environmental protection authorities, civil society representatives; CS Lead.
10 Feb 2022 online event	**SH workshop 1** *"Exploring and linking water-energy-food-ecosystem Nexus in the Lielupe river basin"*	To initiate the discussion of critical WEFE Nexus interlinkages in the Lielupe river basin in the transboundary context and obtain feedback on the draft conceptual model (WP3), to discuss the related policies, potential instruments and their interactions in WEFE sectors (WP1).	LV, LT public initiatives, policy makers at national level, environmental protection authorities, scientific institutions (universities), regional authorities; CS Lead & other consortium members.
Mar - Nov 2022	**Policy inventory and coherence assessment**	To perform the first round of governance and policy	CS Lead, WP1 Team.

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Date	Type of Activity	Purpose	Participants
LV, LT		assessment (WP1).	
May – Sep 2022	**Preliminary assessment of critical cross-sectoral interlinkages**	To obtain information about the most significant nexus cross-sectoral interlinkages for the Lielupe river basin from the SH perspective (WP3).	CS Lead, LV, LT policy makers at national level, environmental protection authorities, scientific institutions (universities), regional authorities (27 May 2022).
27 May 2022, Jelgava, Latvia	**Working group session** at Baltic regional thematic workshop *"Agriculture and good water quality: policy and management measures"*	To discuss critical water-energy-food-ecosystems nexus interlinkages, interactions, impacts and novel policy suggestions for the Lielupe river basin, the Gulf of Riga, the Baltic Sea, to identify the most crucial interlinkages in the draft conceptual model and obtain the priority scoring by SH (WP3).	LV, LT, EE policy makers at national level, environmental protection authorities, scientific institutions (universities), regional authorities; CS Lead.
Jun 2022 - ongoing	**Selection of policy packages**	To perform the second round of governance and policy assessment (WP1) and to draft policy packages (WP1) to be used as input to the NEPAT (WP4).	CS Lead, WP1, WP3, WP4 Team.
Jun 2022 – Dec2023	**Biophysical/socioeconomic model data**	To preliminarily discuss biophysical/socioeconomic data for the Lielupe CS.	CS Lead, WP2 Team.
6-10 Jun 2022 Riga, Jelgava, Latvia; Panevezys, Lithuania	**Lielupe CS visit No1:** *SH interviews in LV & LT*	To understand the local practices of water supply, energy production, food production and ecosystems management and analyze current instruments and policies for water management and their capacity to support a governance based on the integration of the different sectors that use water (WP1).	LV, LT civil society, public initiatives, policy makers at municipalities, policy makers at national level, agricultural authorities, energy authorities, environmental protection authorities, business, research (university), regional authorities; CS Lead, WP1

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Date	Type of Activity	Purpose	Participants
			Team.
Jul-Oct 2022	**Analysis of current SH landscape**	To analyze the initial results of SH engagement in the Lielupe CS.	CS Lead, WP5, WP6 Team.
15-16 Sep 2022 Vilnius, Lithuania	**Lielupe CS visit No2:** *SH interviews in LT*	To obtain additional SH views during interviews on WEFE governance for the Lielupe river basin in Lithuania (WP1).	LT policy makers at municipalities, national level; agricultural, energy, environmental protection authorities, business, research, CS Lead, WP1 Team.
29 Sep 2022 Bauska, Latvia	**Local/regional SH workshop** *"Exploring possibilities for cross-border and 'beyond the projects' cooperation linking water-energy-food-ecosystems in the Lielupe river basin"*	To initiate the discussion on possibilities for cross-border and 'beyond the projects' co-operation between local and regional institutions in the Lielupe river basin in Latvia and Lithuania (WP1).	LV, LT policy makers at local level/municipalities, regional authorities; CS Lead, WP1 Team.
Oct 2022 – Dec 2022	**Main assessment of critical cross-sectoral interlinkages**	To identify the priority cross-sectoral interlinkages in the Lielupe CS via online SH survey in LV and LT (WP3).	CS Lead, WP3 Team, Lielupe CS Stakeholders.
2 Nov 2022 Riga, Latvia	**SH workshop 2** *"Water-energy-food-ecosystem interlinkages in the Lielupe river basin and policy instruments for resource management"*	To present and validate the conceptual model, introduce cross-sectoral integration of policy goals, to hear experts' views on importance of impact of interlinkages between nexus sectors (WP3), to identify important and influential policy instruments (WP1).	LV policy makers at local level, policy makers at national level, environmental protection authorities, business, universities; consortium members.
10 Feb 2023 online	**LT expert meeting "Water-energy-food-ecosystem interlinkages in the Lielupe River basin and policy instruments for resource management"**	To present and validate the conceptual model of Nexus interlinkages for the Lielupe River basin, introduce cross-sectoral integration of policy goals, to hear LT experts' views on the importance of the impact of interlinkages between Nexus sectors, as well as to identify important and influential policy instruments.	LT policy makers at local level, environmental protection authorities, agricultural, energy authorities, river basin authorities, civil society, CS Lead.
9 Mar 2023, online	LV Focus group Policy coherence analysis NEXOGENESIS	To present policy instruments and discuss the results of NEXUS policy coherence	LV policy makers at local level (municipalities),

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Date	Type of Activity	Purpose	Participants
		analysis in Latvia.	regional authorities, civil society, CS Lead, WP1 Lead.
31 Mar 2023, online	LT Focus group Policy coherence analysis NEXOGENESIS	To present policy instruments and discuss the results of NEXUS policy coherence analysis in Lithuania.	LT policy makers, environmental protection authorities, CS Lead, WP1 Lead.
15 Jun 2023, Vilnius, Lithuania	**SH workshop 3** *"Water-energy-food-ecosystem Nexus governance, policies and stakeholder engagement in the Lielupe River Basin"*	To introduce findings from the governance assessment in Latvia and Lithuania, to present and validate policy packages, to discuss stakeholder engagement considerations and to promote networking and exchange of information on ongoing activities in the Lielupe River Basin.	LT and LV River basin authorities, policy makers at national and local level, public initiatives, energy authorities, regional authorities, Consortium members.
Jan – Dec 2023	**Elaboration of SDM for Lielupe River Basin (based on conceptual model)**	To create SDM sub-parts for LV and LT allowing modeling on country bases and for the entire Lielupe RB.	CS Lead, WP3 Team, Lielupe CS Stakeholders.
6-7 Feb 2024, Riga, Latvia	**SH workshop 4** *"Water-energy-food-ecosystem Nexus: from interlinkage modelling to decision support tool and stakeholder agreement for integrated management of the Lielupe River basin"*	To introduce the progress of NXG project activities in the Lielupe Case Study, results of system dynamics modelling and land use modelling, the NEPAT decision support tool and to discuss the needs and possibilities for stakeholder agreements in the Lielupe River Basin to sustain the cooperation beyond the project.	LV and LT policy makers at local and national level, environmental protection authorities, civil society, research, business, consortium members.
Feb 2024 – Feb 2025	**Modelling and feeding in policies to NEPAT**	To select policies in LV, LT, and Lielupe RB and translate into parameters and functions for the NEPAT.	CS Lead, WP3, WP4 Team, Lielupe CS Stakeholders.
Feb 2024 – May 2025	**SH agreement for integrated management**	To facilitate joint activities to promote Latvia-Lithuania transboundary cooperation.	CS Lead, WP1 Team, CS Stakeholders
2 Oct 2024	**SH workshop 5** *"Water-energy-food-ecosystem Nexus: policy assessment and governance roadmap for the Lielupe River Basin"*	To demonstrate possibilities of the NEPAT and provide opportunity for the stakeholders to explore the tool in operation to identify the 'must have' policies for achieving the policy goals	LV and LT policy makers at local and national level, environmental protection authorities, civil society, research, business, consortium members.

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Date	Type of Activity	Purpose	Participants
Mar - Apr 2025	**Focus groups in LV and LT**	To agree on user validated policy packages and road map with agreed actions for the Lielupe RB (based on NEPAT results)	LV and LT policy makers at local and national level, environmental protection authorities, civil society, research, business
Feb – April 2025	**Elaborating SH agreement**	To prepare, agree and sign the Letter of Intent for transboundary co-operation within the Lielupe RB	CS Lead, WP1 Team, CS Stakeholders (LV and LT)
April 2025	**SH workshop 6**	To demonstrate the user validated policy packages, roadmap for implementation, and SH agreement	LV and LT policy makers at local and national level, environmental protection authorities, civil society, research, business, consortium members.
May – Aug 2025	**Maximizing impacts**	To transfer the knowledge on approach for cooperation in transboundary RB setting, to promote user validated policy packages and the roadmap for implementation	CS Leads, WP6 Team, CS Stakeholders (LV and LT)

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Annex 3: List of institutions from Latvia and Lithuania participating at NXG Stakeholder workshops and other SH engagement activities for the Lielupe RB

Nr.	SH/ Institutions in LATVIA	Seminar with SH	Inter-views	Local – regional WS	Focus group	WS1	WS2	WS3	WS4	WS5
1	Latvia University of Life Sciences and Technologies	X	X			X	X		X	X
2	Latvian Environment, Geology and Meteorology Centre	X	X			X		X	X	X
3	Bauska County municipality		X	X	X		X	X	X	X
4	Ministry of Agriculture	X	X			X	X		X	
5	University of Latvia	X				X	X			
6	NGO Green Liberty					X	X			
7	NGO Association “Farmers’ Parliament”	X	X				X		X	
8	Jelgava municipality operative information center (Jelgava Digital Center)						X		X	X
9	Zemgale Planning Region	X	X	X	X	X		X		X
10	NGO Latvian Fund for Nature	X	X				X			
11	NGO Business Development Group					X				
12	Latvian water and wastewater works association		X				X			
13	Laflora Ltd.							X		
14	World Wide Fund for Nature (WWF), Latvia	X						X		

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Nr.	SH/ Institutions in LATVIA	Seminar with SH	Inter-views	Local – regional WS	Focus group	WS1	WS2	WS3	WS4	WS5
15	Latvian State Forest Research Institute Silava								X	
16	NGO Salgale rural support association	X			X				X	X
17	Ministry of Environmental Protection and Regional development	X	X						X	
18	LPKS "LATRAPS"								X	X
19	Jelgava County municipality	X	X							
20	Latvian Rural Advisory and Training centre, Ltd	X								
21	Municipality of Jelgava State City	X								
22	Ltd. Ministry of Agriculture, Real estate	X								
23	Institute of Food Safety, Animal Health and Environment "BIOR"	X								
24	NGO "Baltic coast"	X								
25	Zemgale Regional Energy Agency		X							
26	Rural partnership “Lielupe”, Latvia		X							
27	Ministry of Economics		X							
28	Dobele county municipality		X							

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Nr.	SH/ Institutions in LITHUANIA	Seminar with SH	Inter-views	Local – regional WS	Focus group	WS1	WS2	WS3	WS4	WS5
1	Center for Environmental Policy (AAPC)		X		X		X	X	X	X
2	Kaunas University of Technology					X				
3	Vytautas Magnus University, Lithuania					X				
4	Ministry of Environment	X	X		X		X	X		
5	Lithuanian Energy Agency		X				X	X		
6	Lithuanian Hydrometeorological Service								X	
7	Panevėžys City Municipality		X		X		X		X	X
8	Biržai District Municipality		X						X	
9	Biržai regional park		X	X						
10	Environmental Protection Agency	X	X				X			
11	Vivasol, cheese farmers association		X				X			
12	Pakruojis distric municipality		X							
13	Pasvalys District Municipality			X						
14	Ministry of Agriculture		X				X			
15	Ministry of Energy		X							

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